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ABSTRACT

This booklet is intended to help mainstreamed mentally retarded, emotionally disturbed, or learning disabled high school students acquire a basic understanding of the responsibilities and working conditions of heavy equipment operators and to practice basic math skills necessary in the occupation. The first section provides a brief introduction to the occupation by focusing upon those job tasks of a heavy equipment operator with which the student is likely to be familiar. The next two sections deal with the work environment of the typical heavy equipment operator and the training, education, and experience needed for the occupation. Exercises addressing basic math skills used by heavy equipment operators are provided. Various suggestions are listed for students interested in further exploring the occupation of heavy equipment operator. A glossary and answer sheet conclude the booklet. (MN)

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MATH on the job

Heavy Equipment Operator

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MATH on the job

Heavy Equipment Operator

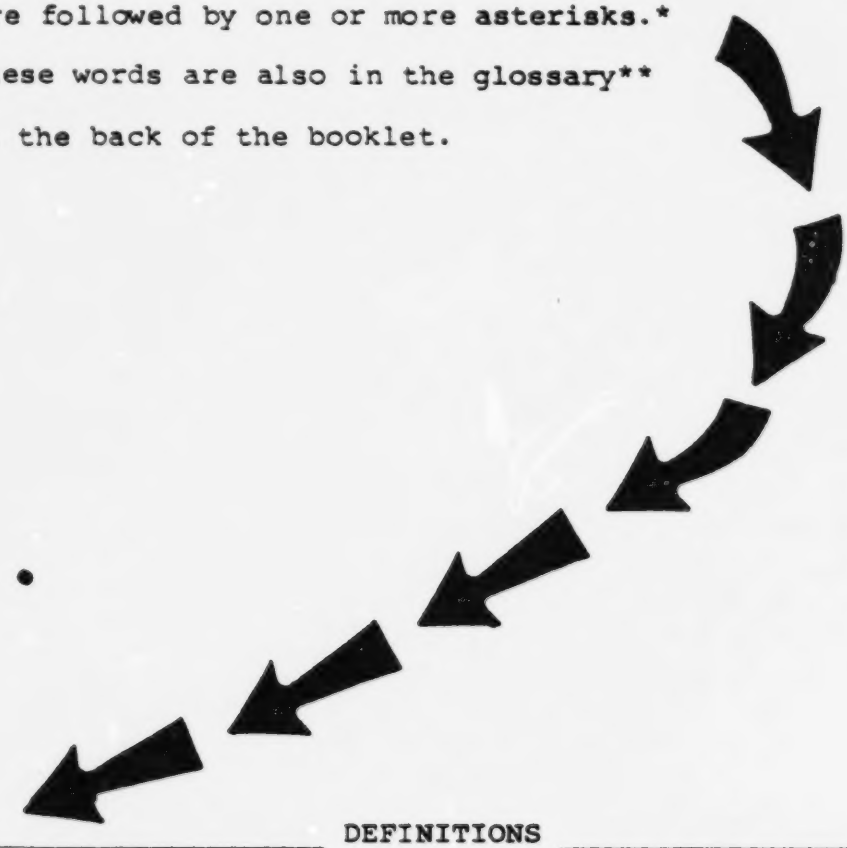
In this booklet, you can--

- find out what a heavy equipment operator does
- see how a heavy equipment operator uses math
- get a chance to use math as a heavy equipment operator
- find out the types of things a heavy equipment operator needs to know
- find out what courses, training, and experience you need to become a heavy equipment operator

SPECIAL WORDS USED IN THIS BOOKLET

Workers in many jobs use special words or special meanings for words. Learning these words helps you to learn about a job.

You will find some of these special words in this booklet. When these words, and some hard words, are used for the first time, they are followed by one or more **asterisks.*** These words are also in the **glossary**** at the back of the booklet.



DEFINITIONS

*An asterisk (*) is a symbol that tells you to look at the bottom of the page for the meaning, or definition, of the word.

**A glossary is a list of words with their meanings.

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HAVE YOU EVER...

- watched a crane operator use the controls on a crane to move materials?
- watched a bulldozer operator move earth with a bulldozer?
- operated a snowblower, tractor, or combine?
- used a **hoist*** to lift and move a heavy object?

If you have, then you have some idea about the work of a heavy equipment operator. This booklet will help you learn more about the work of a heavy equipment operator and how math is important to do the job.

DEFINITION

*A **hoist** is a group of ropes and pulleys arranged in a way that makes it easier to lift and pull an object.

WHAT DOES A HEAVY EQUIPMENT OPERATOR DO?

A heavy equipment operator's main task is to operate various types of power driven construction machines. Sometimes, a heavy equipment operator is called an operating engineer.

A heavy equipment operator also--

- uses pedals and levers to drive the machines
- adjusts handwheels and pushes buttons to control attachments, such as blades, buckets, and scrapers
- turns valves to control air and water output

A heavy equipment operator uses math on the job every day. A heavy equipment operator uses math to--

- add, subtract, multiply, and divide
- read and write whole numbers, decimals, and fractions
- take measurements
- adjust valves to control air and water outputs
- read valves and meters to determine air and oil pressure
- read measurements on scale drawings or **blueprints***
- convert scale measurements to actual size
- carefully guess the weight of materials to be moved
- carefully guess the volume of material to be **excavated****

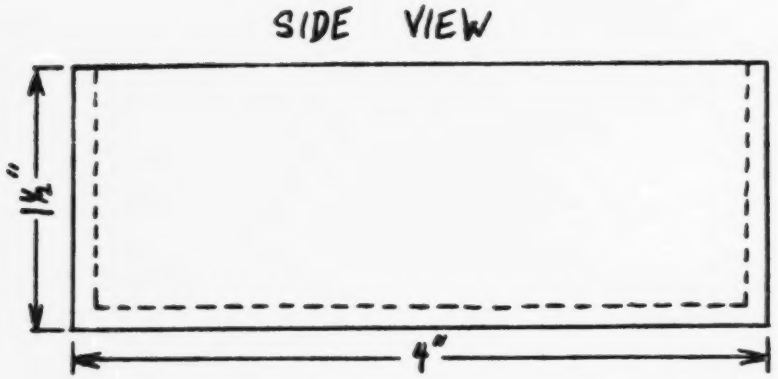
DEFINITIONS

*A <u>blueprint</u> is a hand-drawn picture of how something is to be made or built.

**To <u>excavate</u> is to dig out and remove.

A heavy equipment operator uses math to read blueprints and scale drawings.

EXAMPLE



The scale of the drawing above is 1/8" = 1'. On the scale drawing, the length of the basement is 4". What is the actual length?

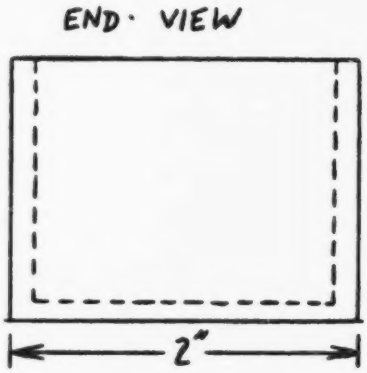
To find the actual length, change 4 to 4/1 and write the ratio

$$\frac{4}{1} : \frac{1}{8} = \frac{4}{1} \times \frac{8}{1} = \frac{32}{1}$$

The actual basement is 32 feet long.

NOW YOU TRY IT

Practice Exercise A



On the scale drawing above, the width of the basement is 2". What is the actual width if the scale is--

	Scale	Actual
1.	1/4" = 1'	?
2.	1/8" = 1'	?
3.	1/16" = 1'	?
4.	1/4" = 2'	?
5.	1/8" = 2'	?
6.	1/16" = 2'	?

A heavy equipment operator uses math to figure out the amount of material to be excavated.

EXAMPLE

A heavy equipment operator is digging a swimming pool that is 45 feet long, 28 feet wide, and 13 feet deep. How much material does the heavy equipment operator need to excavate?

To find the amount, you would use the formula for finding the volume of an excavation. Volume is equal to length times width times heighth (or depth). This formula can also be written as V = L x W x D. In this example, the length is 45 feet, the width is 28 feet, and the depth is 13 feet.

V = 45 x 28 x 13 = 16,380 cubic feet

The heavy equipment operator needs to excavate 16,380 cubic feet of material.

NOTE: Volumes are always measured in cubic units such as cubic inches, cubic feet, or cubic yards.

NOW YOU TRY IT

Practice Exercise B

Use the formula for finding volume to complete the chart below. For this practice exercise, all measurements will be in cubic feet.

Remember: V = l x w x d

	Length (l)	Width (w)	Depth (d)	Volume (V)
7.	32	15	10	?
8.	33	11	9	?
9.	45	32	13	?
10.	21	6	6	?
11.	47	24	3	?
12.	51	22	17	?
13.	55	33	11	?
14.	60	34	18	?

A heavy equipment operator uses math to figure out the cost of excavation.

EXAMPLE

A heavy equipment operator is digging a basement that is 36 feet long, 24 feet wide, and 12 feet deep. The cost of excavation is $1.50 per cubic foot. What is the total cost of excavation for the basement?

To find the cost, first find the volume of the area to be excavated.

$V = l \times w \times d = 36 \times 24 \times 12 = 10{,}368$ cubic feet

Next, multiply the total number of cubic feet to be excavated by the cost per cubic foot.

$10{,}368 \times \$1.50 = \$15{,}552.00$

The total cost for excavation is $15,552.00.

NOW YOU TRY IT

Practice Exercise C

Find the total cost of excavation for each of the following problems.

	Length (l)	Width (w)	Depth (d)	Cost Per Cubic Foot	Total Cost of Excavation
15.	10	3	6	$ 1.00	?
16.	15	7	6	1.00	?
17.	32	11	8	1.50	?
18.	40	13	9	1.50	?
19.	42	17	10	2.00	?
20.	45	15	5	2.00	?
21.	50	20	15	2.25	?
22.	52	23	18	2.25	?

A heavy equipment operator uses math to determine the safe load for a pile.*

EXAMPLE

Some heavy equipment operators construct homes built on pile foundations. A machine called a pile driver drops a heavy hammer on the pile to drive it into the ground. A heavy equipment operator determines the weight that can be supported by a pile (the safe load) by using the following formula:

$$P = 2wh/(s+1)$$

P = the safe load in pounds
w = the weight of the hammer in pounds
h = the distance in feet the hammer falls
s = the distance in inches the pile moves when hit

Assume that the weight of the hammer is 4,000 pounds. When the hammer falls 10 feet, it moves the pile 3 inches. What is the safe load that could be supported by the pile?

$$P = 2wh/(s+1) = 2(4000)(10)/(3+1) = 20{,}000$$

The safe load of the pile is 20,000 pounds.

NOW YOU TRY IT

Practice Exercise D

For each problem, find the safe load of a pile using the formula. Round your answer to the nearest whole number. Remember: $P = 2wh/(s+1)$

23.	W = 1000,	h = 10,	s = 1,	P = ?
24.	W = 2000,	h = 10,	s = 2,	P = ?
25.	W = 3000,	h = 15,	s = 2,	P = ?
26.	W = 2500,	h = 8,	s = 3,	P = ?
27.	W = 3000,	h = 7,	s = 3,	P = ?
28.	W = 2000,	h = 9,	s = .75,	P = ?

DEFINITION

*A pile is a long slender column made of timber or steel. A pile is driven into the ground and used for support.

WHERE DOES A HEAVY EQUIPMENT OPERATOR WORK?

As a heavy equipment operator, you may work for many different types of businesses. You may work for--

- a contractor who builds highways, dams, or airports
- a building contractor who builds houses, hospitals, schools, and office buildings
- a utility company*
- a manufacturer
- a government agency
- a factory
- a mine
- a steel mill

You may operate many different machines and pieces of equipment. You may operate--

- bulldozers
- power shovels
- cranes
- tractors
- paving machines
- trench excavators
- pile drivers
- concrete mixers
- pumps
- hoists
- derricks
- back-hoes

DEFINITION

*A utility company is a business that provides light, power, water, or telephone service to the general public.

There are many different types of heavy equipment operators. Some heavy equipment operators specialize and only operate one type of machine, such as--

- an air compressor operator, who tends machines that take in air and force the air through a narrow hose. The air is used to run tools, such as jackhammers.
- a crane operator, who uses electric, diesel, gasoline, or steam-powered cranes to move products, equipment, or materials.
- a bulldozer operator, who uses bulldozers to level and distribute earth and remove trees, rocks, and debris from a building site.
- a concrete paving machine operator, who uses concrete paving machines to spread and smooth poured concrete surfaces, such as those used for roads and airport runways.
- a roadroller operator, who drives a heavy rolling machine called a roadroller. The roadroller compacts the earth so that highways and streets can be built.
- a well-drill operator, who sets up and operates portable drilling rigs to drill wells.

As a heavy equipment operator, you will work with many different people. You will work with--

- a supervisor, who will tell you what to do and help you solve any problems.
- other heavy equipment operators and construction workers. Sometimes, these workers will give you hand or flag signals or radio instructions to help guide you in your work.
- heavy equipment operators' helpers. Sometimes these helpers are called oilers. They make sure the machines have gas and oil. They also make minor repairs and adjustments to the machines.

IF YOU ARE INTERESTED IN

THE WORK OF A HEAVY EQUIPMENT OPERATOR

AND WOULD LIKE TO KNOW MORE,

READ ON

WHAT TRAINING, EDUCATION, AND EXPERIENCE DO YOU NEED TO BECOME A HEAVY EQUIPMENT OPERATOR?

What do you think? Would you like to be a heavy equipment operator? If you would, there are some things you should know. You should know how--

- to drive
- engines operate and should be repaired
- to judge distance and height
- to use your eyes, hands, and feet as a unit

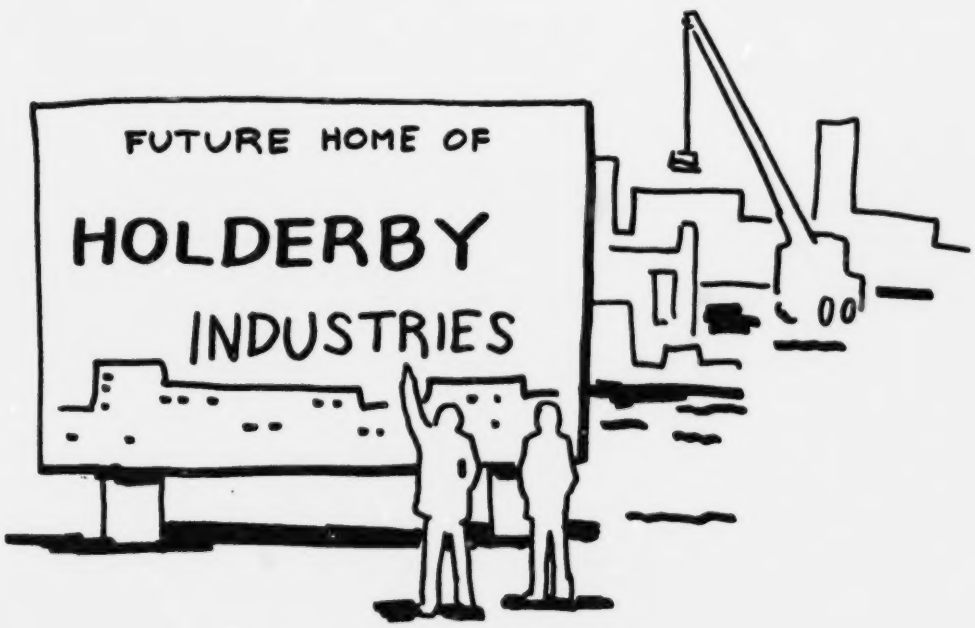
To become a heavy equipment operator, you should be a high school graduate. While in high school, you should take classes in driver's education and auto mechanics. Knowing how to drive a tractor or other farm machinery also will help you learn about the job.

The best way to get a job as a heavy equipment operator is to enter an apprenticeship program. Usually, the apprenticeship program will last three years. You will receive training on the job and also attend classes. In the classes, you will learn about engine operation and repair, cable splicing, hydraulics, safety, and first aid.

Some heavy equipment operators have received all of their training on the job. Other operators received training in the military service or in private vocational schools.

You might want to get a job as a heavy equipment operator's helper or oiler. As you learn about the machines and how they operate, you might be given the opportunity to operate them.

Taking every chance to learn about the machines and how they operate will help you get a good job. Showing that you have the math skills to do the job will also help you.



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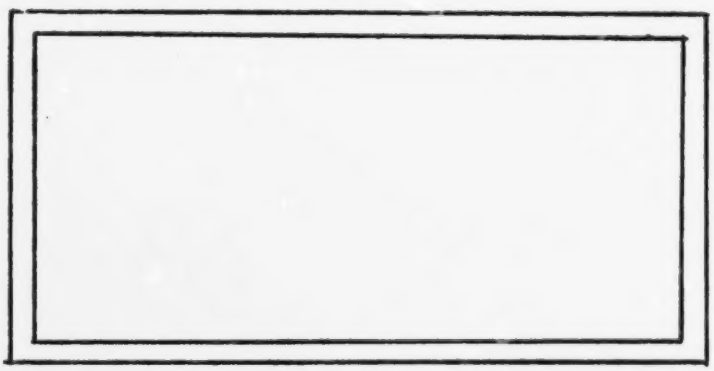
DO YOU WANT TO DO MORE
HEAVY EQUIPMENT OPERATOR'S MATH?

Practice Exercise E

TOP VIEW



On the scale drawing above, the depth of the basement is 1-1/2". What is the actual depth if the scale is--

	Scale	Actual
29.	1/4" = 1'	?
30.	1/8" = 1'	?
31.	1/16" = 1'	?
32.	1/4" = 2'	?
33.	1/8" = 2'	?
34.	1/16" = 2'	?

Practice Exercise F

Use the formula to find the volume in cubic feet from the data in the chart below. Remember: V = l x w x d

	Length (L)	Width (W)	Depth (D)	Volume (V)
35.	47 ft.	16 ft.	9 ft.	?
36.	59 ft.	32 ft.	17 ft.	?
37.	65 ft.	35 ft.	15 ft.	?
38.	67 ft.	33 ft.	14 ft.	?
39.	69 ft.	37 ft.	19 ft.	?
40.	72 ft.	40 ft.	21 ft.	?

Practice Exercise G

Find the total cost of excavation for each of the following problems.

	Length (l)	Width (w)	Depth (d)	Cost Per Cubic Foot	Total Cost of Excavation
41.	15	15	10	$ 1.25	?
42.	35	17	12	1.50	?
43.	41	19	11	1.00	?
44.	57	13	9	1.75	?
45.	62	15	14	2.00	?
46.	70	25	15	1.50	?

Practice Exercise H

For each problem, use the formula for finding the safe load of a pile. Use the values given. Round your answer to the nearest whole number.
Remember: P = 2wh/(s+1)

47. W = 3000, h = 15, s = .75, P = ?
48. W = 2000, h = 9, s = .5, P = ?
49. W = 2500, h = 13, s = .5, P = ?
50. W = 3000, h = 12, s = 1.5, P = ?
51. W = 3500, h = 8, s = 1.5, P = ?
52. W = 2000, h = 15, s = .75, P = ?

DO YOU WANT TO EXPLORE SOME MORE?

1. Visit a construction site. Identify and write down the different types of equipment and machinery that are being operated. Describe how the machinery and equipment is being used on the job.

2. Contact a contractor or the local operating engineers' union. Ask about the requirements to enter the apprenticeship program. Ask what high school courses you should take to be eligible for the program. Ask if there is an entrance test to join the apprenticeship program.

3. If possible, arrange to talk with a heavy equipment operator. Ask about the types of equipment and machinery the operator uses. Ask what the heavy equipment operator likes and dislikes about the work. Ask how he or she became a heavy equipment operator.

4. Are you interested in other jobs where you could operate machinery?

   - **Conveyor operators** move controls on a conveyor system to regulate the rate of movement of materials on the system.

   - **Stevedores** load and unload cargo from ships.

   - **Long-wall mining machine tenders** monitor the electric control panel for mining machines.

   - **Oil well perforator operators** operate truck-mounted hoisting equipment and control panels. They position and explode powder or chemical charges in oil or gas wells.

   You must have good math skills to do these jobs well. Most of these workers use addition, subtraction, multiplication, and division on the job every day.

GLOSSARY

Asterisk (*): a mark that tells you to look at the bottom of the page for the meaning, or definition, of the word.

Blueprint: a hand-drawn picture of how something is to be made or built.

Excavate: to dig out and remove.

Glossary: a list of words with their meanings.

Hoist: a group of ropes and pulleys arranged in a way that makes it easier to lift and pull an object.

Pile: a long slender column made of timber or steel. A pile is driven into the ground and used for support.

Utility company: a business that provides light, power, water, or telephone service to the general public.

ANSWER SHEET

Practice Exercise A

1. 8'
2. 16'
3. 32'
4. 16'
5. 32'
6. 64'

Practice Exercise B

7. 4,800
8. 3,267
9. 18,720
10. 756
11. 3,384
12. 19,074
13. 19,965
14. 36,720

Practice Exercise C

	Volume (V)	Total Cost of Excavation
15.	180	$ 180.00
16.	630	630.00
17.	2,816	4,224.00
18.	4,680	7,020.00
19.	7,140	14,280.00
20.	3,375	6,750.00
21.	15,000	33,750.00
22.	21,528	48,438.00

Practice Exercise D

23. 10,000 pounds
24. 13,333 pounds
25. 30,000 pounds
26. 10,000 pounds
27. 10,500 pounds
28. 20,571 pounds

Practice Exercise E

29. 6'
30. 12'
31. 24'
32. 12'
33. 24'
34. 48'

Practice Exercise F

35. 6,768
36. 32,096
37. 34,125
38. 30,954
39. 48,507
40. 60,480

Practice Exercise G

	Volume (V)	Total Cost of Excavation
41.	2,250	$ 2,812.50
42.	7,140	10,710.00
43.	8,569	8,569.00
44.	6,669	11,670.75
45.	13,020	26,040.00
46.	26,250	39,375.00

Practice Exercise H

47. 51,429 pounds
48. 24,000 pounds
49. 43,333 pounds
50. 28,800 pounds
51. 22,400 pounds
52. 34,286 pounds